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FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

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NAVAL SURFACE WARFARE CENTER

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ORGANIZING FOR NUMERICAL CONTROL PRODUCTION

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New Orleans, Louisiana

Mr. Nuzzo is the Assistant Superintendent of the Mold Loft and Director of Numerical Control. He has 23 years experience in the mold loft at Avondale and has spent the last ten years in developing the usage of numerical control.

What is the optimum organizational pattern for NC in a shipyard? In an attempt to answer this question, we carefully reviewed our NC operations at Avondale.

Let us regress to 1938, when Avondale began. Avondale Marine Ways purchased the equipment once used to ferry railroad cars across the Mississippi River, and started a marine repair service. Later, as work increased, small boats and barges were constructed.

Today's facility is a modern shipyard employing 8500 workers , and is Louisiana's largest private industrial employer.

In the last ten years Avondale has constructed a large variety of ships.. Destroyer escorts and Coast Guard cutters, as well as commercial oil and *cargo* carriers, have been delivered. Among our more recent accomplishments is the completion of a large number of LASH vessels and semi-submersible drilling rigs. Presently, we have in service a 900' floating drydock, built by Avondale, to accommodate the launching of the LNG ships now under construction.

By the mid-1960's, we were successfully utilizing engineering and hull calculation programs. Our IBM 1401 computer was performing tedious and time consuming calculations quickly and accurately.

At this time, we signed a contract to construct 27 destroyer escorts. These ships had very complicated webs of 3/4" plate in the sonar domes that would require many man-hours to burn. To cut these webs, an Airco Servograph machine was

purchased. This was our first attempt at automatic burning. Fuli size templates, drawn with ink on opaque film, were needed to control this machine. Since these templates were very costly to produce by hand, we turned to our computer. A simple program, designed to generate a curve, fit a radius in a corner, and draw a hole, was developed to aid in producing the templates used by the servograph machine. The program generated a paper tape for producing full size templates on a leased 4¹x5′ Kongsburg drafting machine.

With the advent of supertankers and the outlook for new and larger contracts, Avondale embarked on a $32,000,000 expansion program. Limited acreage and larger ships prompted a need for a highly efficient method of cutting steel. Thus, Avondale turned to NC. Property was acquired for a new plate shop, fabrication area, and steel storage facility. Modern steel handling equipment was purchased, and a Kongsburg drafting machine and director were installed. Two Messer Griesheim burning machines and two flame planers′ were also put into operation.

While this equipment was being installed, our "in house" program was being improved with new commands and features. Working with the Mold Loft in a production oriented environment, our programmers created a system that served us well for the next seven years.

Originally,. NC responsilbilities were shared by engineering and production personnel. *However,* because of work schedules and a knowledge of lofting practices, the Mold Loft assumed

a substantial role in Avondale's 'NC development. Later, it became evident that in order to maintain production schedules, it was necessary to further centralize NC operations. Today, with the exception of the Scientific and Computer Applications sections, NC is an integral part of production operations.

In 1973, Avondale contracted with Cali and Associates, to develop and install Avondale "SPADES."

To date, with the "SPADES" system, LNG tankers, drilling rigs, large and small barges, and our drydock have been successfully completed. Presently, we are working on four 164,000 DWT tankers;

Since the division of responsibilities differs from shipyard to shipyard, let us now look at Figure 1 which depicts the structure of each management group at Avondale - Administration, Engineering, and Production. It is interesting to note that our computer is being controlled by the Administrative group rather than by Engineering. This condition exists because our computer was primarily used for administrative type programs before engineering and NC programs were present at Avondale.

There are four NC related departments under the Engineering Vice President.

Computer Applications

The task of the Computer Applications Section is the development of software for any shipyard function that can be computerized. This deprtmen't also has personnel working with

AVONDALE'S ORGANIZATIONAL STRUCTURE **OF N.C. RELATED DEPARTMENTS**

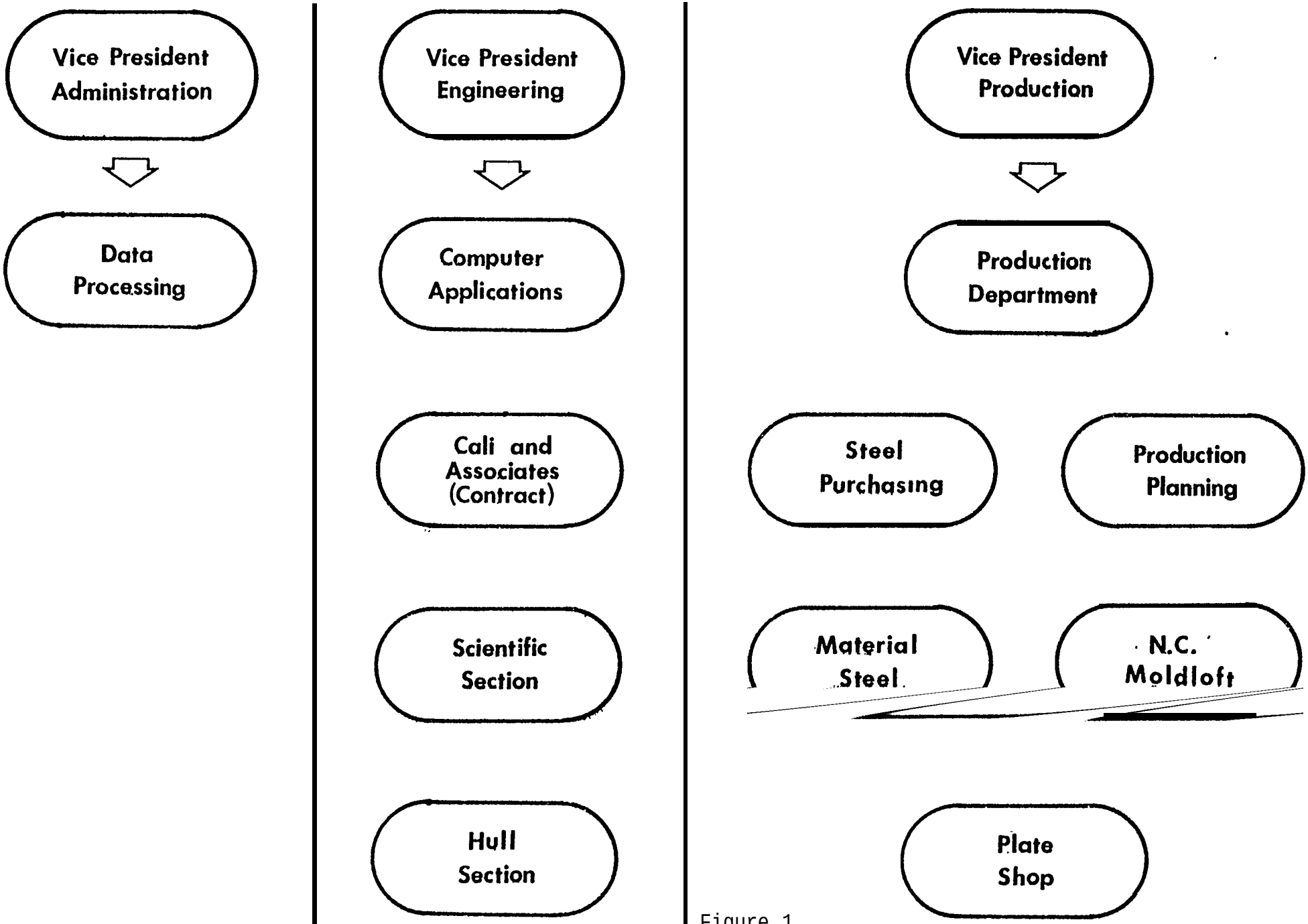


Figure 1.

modifications to "SPADES."

Computer Applications is also responsible for fairing the ship's envelope, generating the frames, and producing offsets for engineering and the field. Computer Applications is equipped with a Kongsburg 8 'x12 '. drafting machine, Kongsburg director, and an IBM System 7 satellite unit. Management is now reviewing the possibility of shifting the fairing responsibility to Hull Engineering or the NC Mold Loft.

Cali and Associates

Cali and Associates is under contract to Avondale for the development and maintenance of our NC system. In addition to NC responsibilities, Cali and Associates is also responsible for the development and maintenance of the hull calculation programs. This organization, along with Avondale personnel, is in the process of developing other new programs.

Scientific Section

Basic structure and hull design is the primary responsibility of the Scientific Section. These tasks are accomplished by use of the "SPADES" hull calculation program and a number of programs developed by Avondale.

As the first users of the data base , their structure design is oriented so that blueprint involvement and parts generation are geared for NC production. Information for the

data base, such as stringer locations and sight edges, is also acquired from this group.

Engineering Hull Section

Engineering detailing and blueprint production is the job of our Hull Section. Working closely with the Production Department, Production Planning, and the NC Mold Loft, information vital to our field operations is gathered for refining the hull drawings.

Emphasis is placed on standardization; items such as holes, brackets, cut-outs, and webs are designed to complement our NC operation.

With a decreasing work load, our hull engineers were recently able to go through a brief NC training period. The purpose was to acquaint the draftsman with the wealth of information available in the data base and to introduce him to the NC tools available for his use. Certainly, this will help him in creating drawings that are pictorially and dimensionally accurate.

The steel take-off group is also a part of Hull Engineering. By utilizing the "SPADES" shell plate program, exact shell plate sizes are obtained. Hull engineering and scantling drawings are used for the balance of the steel take-off. These People prepare the original bill of materials for every job.

There are six NC related departments under the Vice President in charge of Production.

Production Department

The production Department's function is to organize and control all phases of production operations in the yard.

Numerical control contributes to their operation by furnishing valuable information for production work. Sketches of burning tapes with computed burning time, quantity of plates to be cut., and an accurate representation of the steel part are important aids in the issuance of work orders.

The format of work orders has also changed because of NC. Work orders were issued by drawing, detail, and piece numbers; they are now issued primarily by tape numbers.

Using NC sketches, the production engineer can carefully monitor the allotment of man-hours needed by the plate shop, thereby increasing plate shop productivity.

Steel purchasing

The Steel Purchasing group, working with Production Planning and Material Departments , is responsible for ordering all steel plates and structurals.

Originally, Steel Purchasing was under the Vice President of Administration. However, because of their impact on production scheduling, steel storage, and handling, this section was transferred to the control of the Vice President in charge of Production.

Production Planning

Production Planning is the first section to look at prospective jobs, and to aid management in determining future production schedules. When the proposed contract becomes a reality, the planners produce a detailed work outline for the yard. The hull is divided into units and sub-units (Figure #2). Locations for master butts and stock requirements are decided upon as well as the erection sequence. This information is then used to determine the master erection schedule (Figure #3) and the ground assembly schedule (Figure #4). The planners also prepare an outline of each Units' structure which is used by the steel section for detailing the unit books (Figure #5).

Material (Steel) Section

Material Steel Section has complete control of steel plates and structural. Their first job is to screen the Hull Section's bill of material against yard stock. Grouping of odd size plates and structurals for economical storage is also implemented into the bill of material. Material yard arrival schedules, handling, identifying, storage, and delivery of steel are Material Section functions. Detailed information of pieces and storage location go into the unit book.

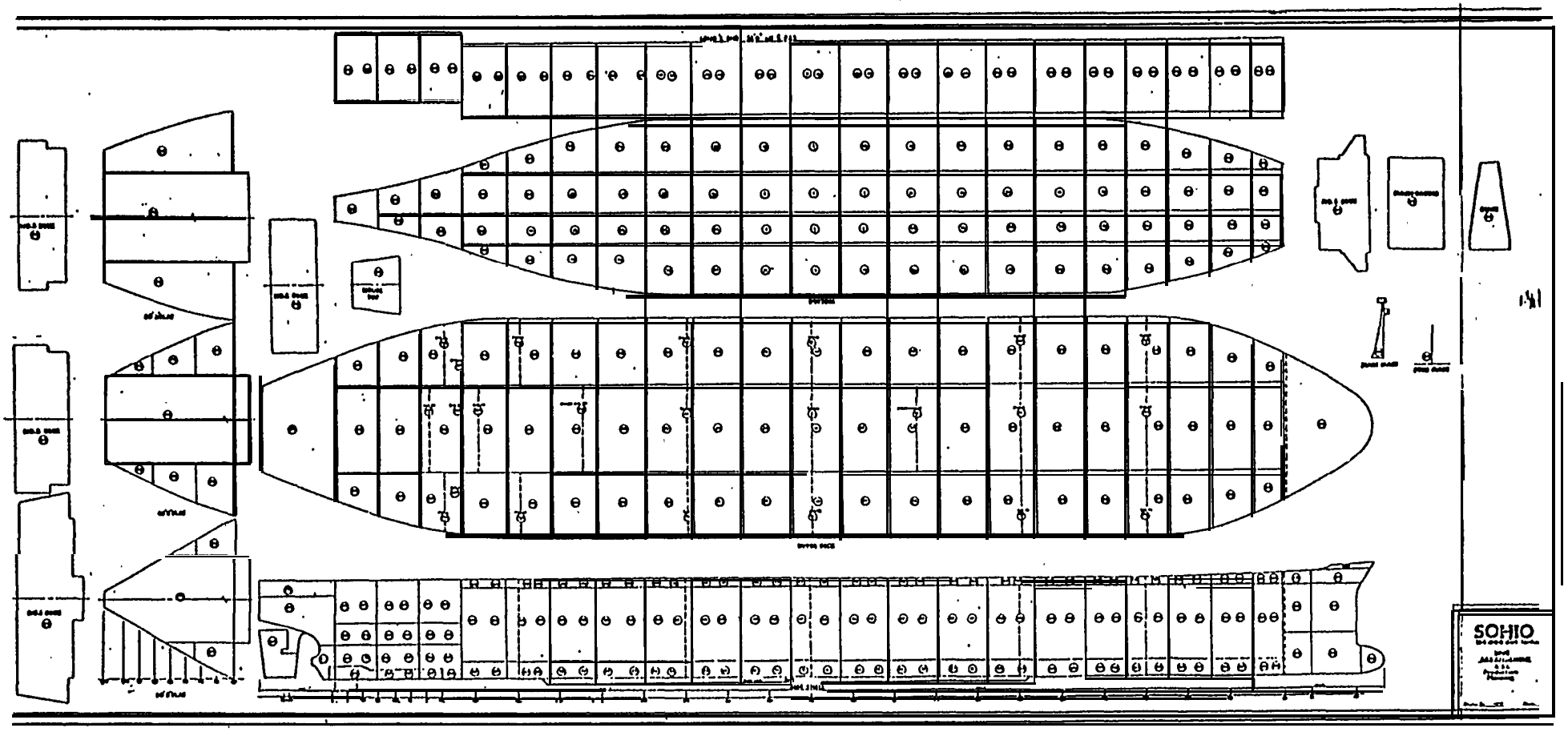


Figure 2.

LAY KEEL 7-12-76
LAUNCH 6-11-77
DELIVERY 10-18-77

AVONDALE SHIPYARDS INC.
MASTER ERECTION SCHEDULE

SOHIO
PIPING

FAB
INSTALL

ASI JOB C4-1620

ASI HULL NO.2295

1976 & 1977

MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY

KEEL

	DESCRIPTION	
1	Tank Heating Coils	48-10-21
2	Cargo & Ballast In Tank Piping	48-00-24
3	Vents, Snds. & Overflows Sl-6B Non-Cargo	48-09-13
4.	Vents, Snds. & Overflows Fwd. Sl Non-Cargo	48-09-14
5	O.B. Disch.Shell Exp. &Sea Valves	48-23-03
6	Cargo Tank Vent Sys. Sl-6J	48-09-22
7	Power Operated Valves	48-24-01
8	Cargo Tank Vent Sys. Fwd. Sl	48-09-21
9	Inert Gas Sys. Inside Cargo Tanks	48-17-24
10	Cargo Oil Tk. Clean,Upr.Dk.Aft.Fr.50	48-05-33
11	Cargo Oil-Upr. Dk. Fwd Fr.54	48-17-11
12	Inert Gas - Upr. Dk. Fwd. Fr. 50	48-17-22
13	Foam Sys. - Upr. Dk. Fwd. Fr. 50	93-00-11
14	Foam Sys. - Upr. Dk. Aft. Fr. 50	93-00-12
15	Hyd. Pipe - Upr. Dk. Fwd. Fr. 50	16-01-12
16	Hyd. Pipe - Upr. Dk. Aft. Fr. 50	16-01-13
17	Firemain Upr. Dk. Aft. Fr. 51	48-03-15
18	Cargo Oil - Upr. Dk. Aft. Fr. 54	48-17-12
19	Inert Gas - Upr. Dk. Aft. Fr. 50	48-17-23
20	Misc. Mn. Dk. Fill Piping	48-00-21
21	F.O. & D.O.Fill & Transv. Upr. Dk.	55-01-11
22	Slop & Bilge Holding Tank	48-00-15
23	*Cargo & Ballast H&L Level Alarm Sys.	87-00-05
24	Tk. Level In Tks. Fwd. of Fr. 69	87-00-11
25	Firemain Upr. Dk. Fwd. of Fr. 51	48-03-14
26	Cargo Oil Tk. Clean Upr. Dk. Fwd.50	48-05-32
27	Control Air - O.M.S.	49-02-22
28	Lift of Gages	87-00-01
29	List of Thermometers	87-00-02
30	S.W. Ballast-Eng Rm Innerbottom	48-00-17
31	Ballast Pump Suct Strainer Assem.	48-01-04
32	Bilge Pump Suct. Strainer Assem.	48-01-05

SHT 1 OF 5 REV

321

Figure 3.

LAY KEEL 7-12-76
POS NO.1 7-12-76
POS NO.3 12-3-76
LOAD-OUT
LAUNCH 6-11-77

GROUND ASSEMBLY SCHEDULE
SOHIO C4-1620

HULL 2295 SHT.1

DATE: 1-12-76

LEGEND:
- ● START PRE-FAB
- ▲ START SUB-ASSY
- ■ START MN-ASSY
- ▲ BLAST & PAINT
- Ⓔ ERECT

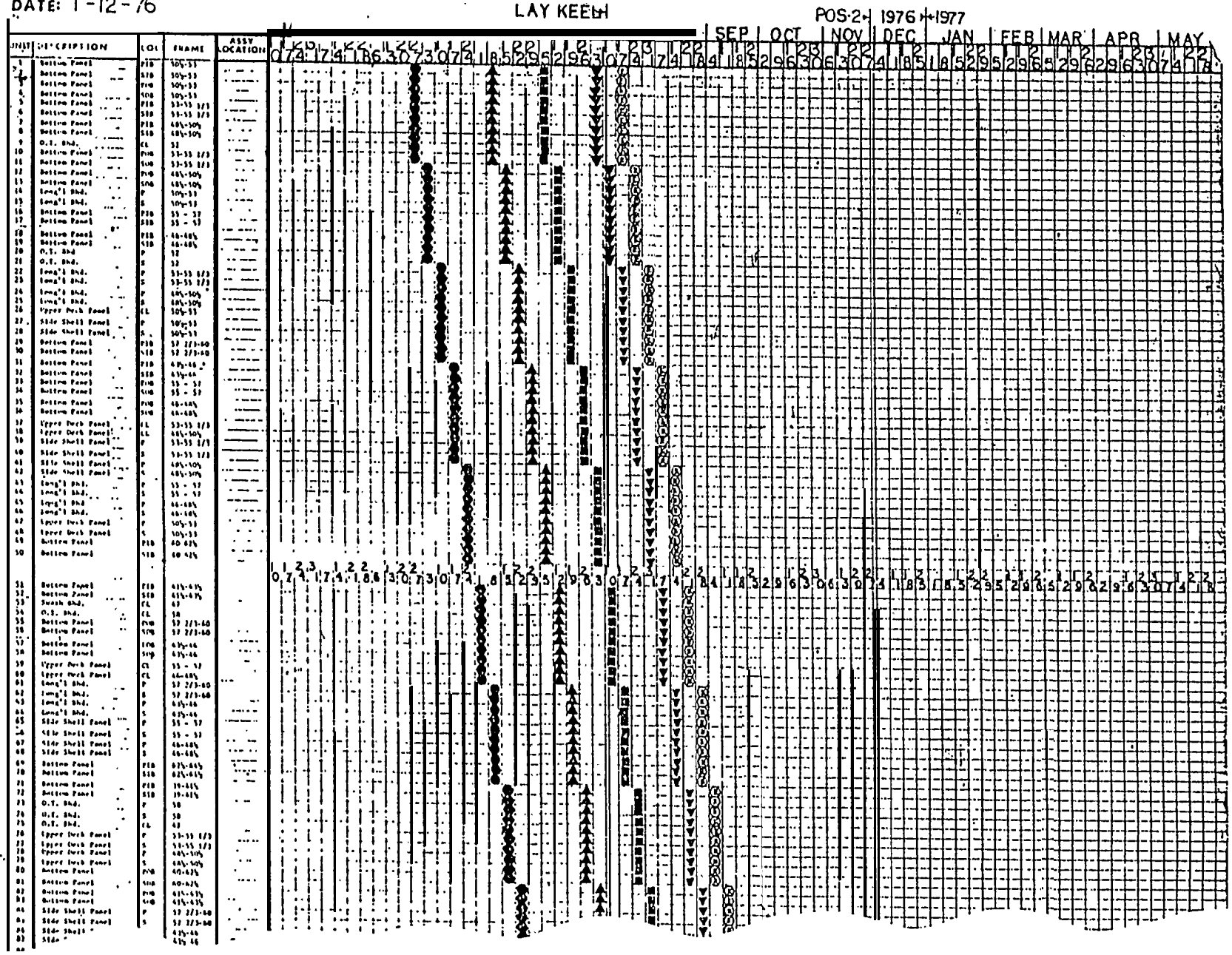


Figure 4.

HULL NO. | AVONDALE SHIPYARDS, INC. | UNIT NO. 127 Port 128 Stbd.

ASSY AREA | PREFAB & ASSY. SHEET | SHEET NO. 18 OF 20

JOB NO. C4-1620. | Outboard Bottom Panel Fr. 64½ - 66½ | DWG. NO. 11-05-042 Ref.-1 11-05-04

	PIECE MARK	QUANTITY 127-S 128-S	DESCRIPTION	TYPE OF STEEL	DWG. DETAIL	LOFT INFO	STD. PC MK	REMARKS	WEIGHT 127-S	WEIGHT 128-S	
1			Transv. Bhd #66 Stringer#3	P/S							1
2	127-2-292 128-5-292	1	1	Pl 5625 x 72" x 9' 9-3/8"	AH-36	10-A	610479			1347	1347	2
3	127-2-294 128-5-294	1	1	Pl 5625 x 108" x 16' 9-11/32"	"	"	"			3465	3465	3
4	127-2-296 128-5-298	1	1	Pl..5625 x 98" x 39' 0" App	"	"	610481			5809	5809	4
5	127-5-238 128-5-238	1	1	Pl..5625 x 91" x 13' 0" App	"	"	610480			2262	2262	5
6	127-5-304 128-5-304	1	1	Pl..5625 x 18" x 6' 6" App								
7	127-5-249											
8	127-2-252 128-5-253	1	1	Pl. 1. x 18" x 10' 1-1/8"	"	10a-11c	NT			618	618	8
11	127-2-300 128-5-306	1	1	Pl 1 x 18" x 11' 6-9/16"	"	" "	NT			95	95	11
12	127-2-261 128-5-261	1	1	FB 1 x 6" x 3' 4"	GR-A	" 601	Temp.			68	68	12
13	127-2-260 128-5-260	1	1	Pl 5625 x 10" x 10' 1-1/4"	"	" "	"			193	193	13
14	127-2-247 128-5-247	1	1	FB 5 x 6" x 5' 1-3/8"	"	" 11B	"			55	55	14
15	127-2-276 128-5-292	1	1	FB 5 x 6" x 3' 4"	"	" "	"			34	34	15
16	127-2-272 128-5-292	1	1	FB 5 x 8" x 8' 10"	"	" 6D	"			120	120	16
17	127-2-274 128-5-294	1	1	Pl 5625 x 10" x 8' 10"	"	" 601	Servo			169	169	17
18	127-2-302 128-5-302	1	1	FB 5 x 6" x 3' 5"	"	" 11B	Temp.			35	35	18
19	127-2-250 128-5-250	1	1	FB 5 x 6" x 5' 5-3/8"	"	" "	"			56	56	19
20												20
	PIECE TOTAL			SHT. REV.				TOTAL WEIGHT		17186	17186	

UNIT NO: 127 & 128-5 SHEET 18 OF 20

Figure 5.

NC Mold Loft

The NC loft manages and controls the data base for all jobs. Information is passed from the Scientific, Computer Applications , and Hull Sections to the NC loft for continual updating of the data base. Initial hulload and hulload maintenance are prepared by NC loft personnel. This is done in cooperation with the Hull and Scientific Sections.

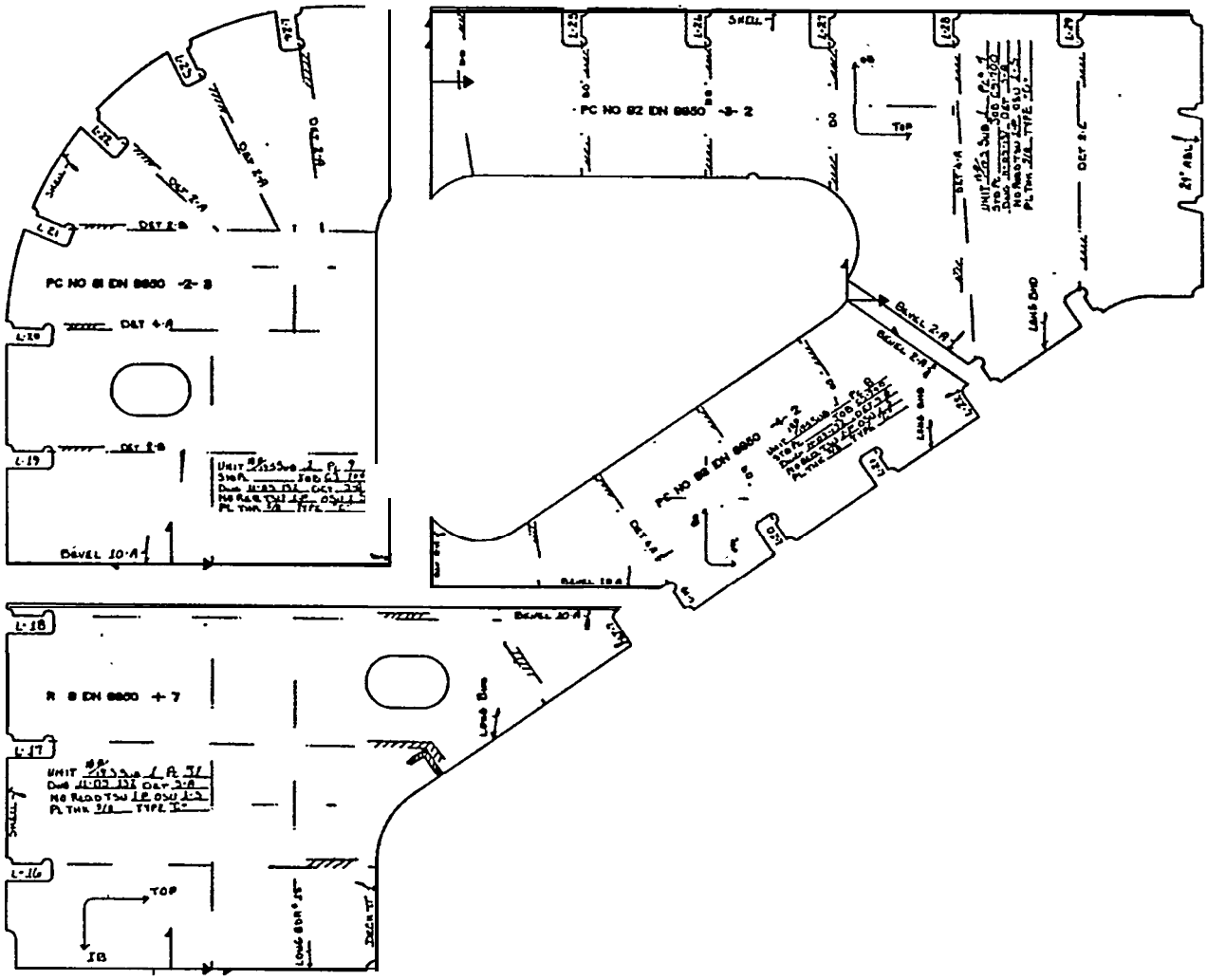
Part generation (Figure 6), nesting (Figure 7), frame-bending, and yard sketches are also functions of the NC loft. NC burning tapes and template information is completed in the unit books; this is done by the NC loft prior to the books' being sent back to Production for distribution.

NC loft equipment consists of a Kongsburg drafting machine and director, System 7, and IBM printer, and 4 IBM 2250 CRT Units tied to an IBM 2840;

Although the NC loft is-not responsible for- fairing, occasions have arisen where we have successfully faired a number of ships.

Plate Shop

All the steel used in the yard is processed through the Plate Shop whose output capacity is 800 plates per week. Because the Plate Shop is located strategically between the steel storage and fabrication platens, material flow is automated (Figure 8) . A 17 ton capacity Via Nova crane automatically loads plates onto a conveyer system that leads into a Pangborn



TAPE NO. 109950 -11

Figure 6.

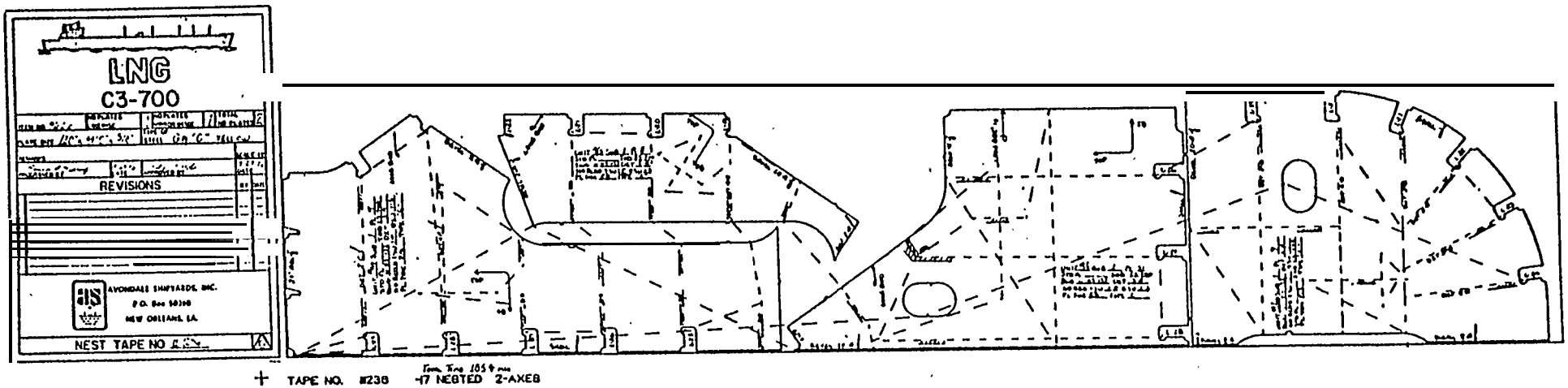

LNG
C3-700
REVISIONS
AVONDALE SHIPYARDS, INC.
NEW ORLEANS, LA.
NEST TAPE NO.
TAPE NO. #238
-17 NESTED 2-AXES

Figure 7.

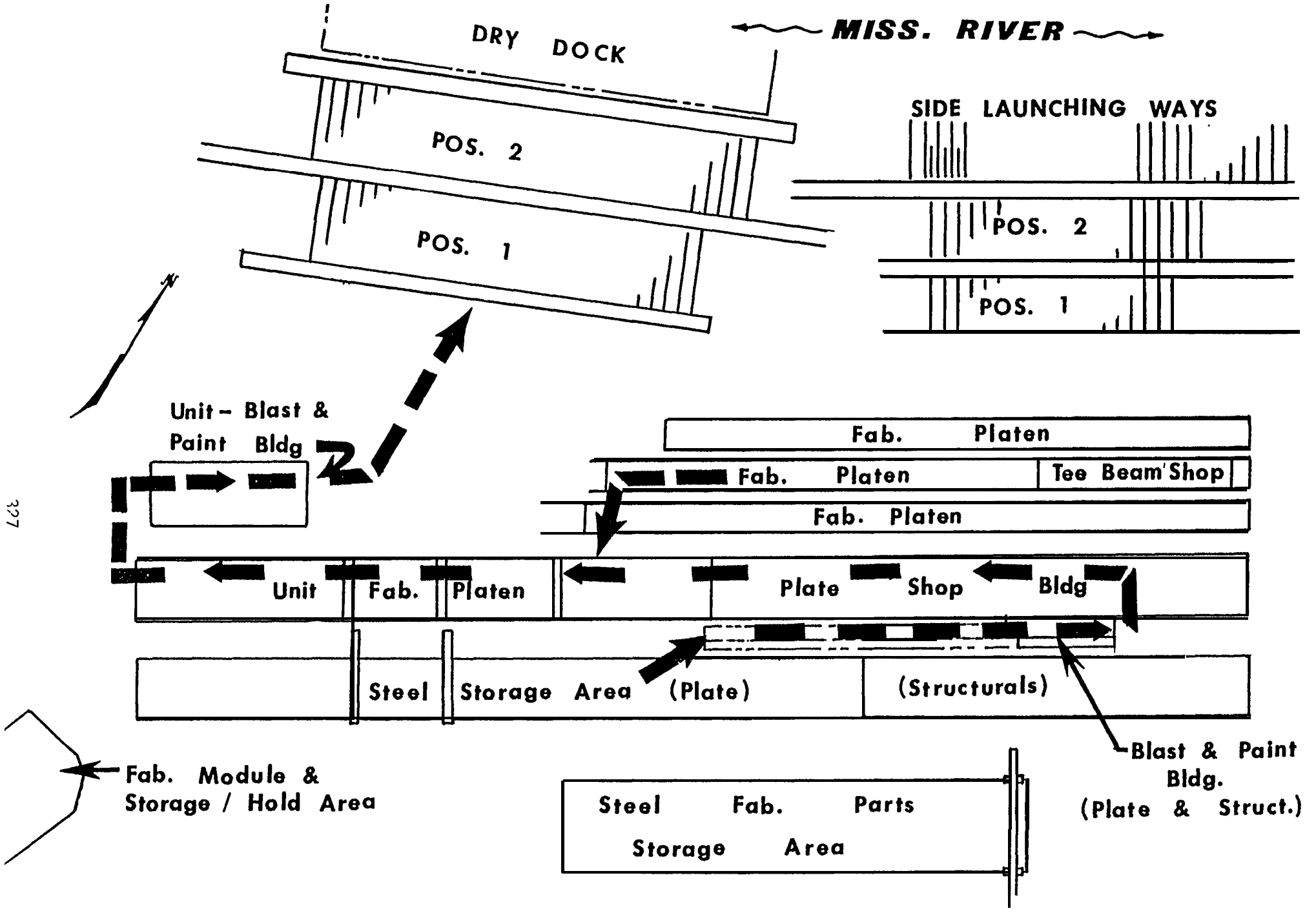

DRY DOCK
MISS. RIVER
SIDE LAUNCHING WAYS
POS. 2
POS. 1
POS. 2
POS. 1
N
Unit – Blast & Paint Bldg
Fab. Platen
Fab. Platen
Tee Beam Shop
Fab. Platen
Unit
Fab.
Platen
Plate
Shop
Bldg
Steel
Storage Area
(Plate)
(Structurals)
Blast & Paint Bldg. (Plate & Struct.)
Fab. Module & Storage / Hold Area
Steel Fab. Parts Storage Area

Figure 8.

shot blaster, and through a Binks paint booth. Structural are deflanged, if required, and processed through an adjacent automated system. Plates or structurals can be directed back to storage or onto the collator automatic stacking in the , Plate Shop. This system is controlled from a console located over the paint and blast booth. Two 17-1/2 ton Via Nova cranes then distribute. the plates to the appropriate machines. Figure #9 shows the layout of the Plate Shop.

Our NC burning equipment includes two Messer Greisheim and two C.R.O. (2 two axis and 2 three axis machines, with bevel capability) burning machines. each machine has eight burning heads (4 master torches and 4 slave torches). All of our NC burning machines are directed by Kongsburg directors linked with IBM System 7.

Paper tapes are kept as a means of emergency “back-up”. Other burning equipment in our plate shop includes two C.R.O. flame planers and one servograph machine. The rest of our shop equipment is composed of presses, Rolls, shears, a newly installed panel line and a 700 ton Hugh Smith frame bender.

Adjacent to the plate shop is the pre-fabrication area and Tee beam manufacturing facility. Sub-units, girders, webs, etc. are moved from this site to the unit fabrication platens located at the end of the plate shop. Completed units then go through the snot blast and paint building to have the interiors finished. These units are. then transported by trailer or crane to a holding area or to the ship assembly area across the levee.

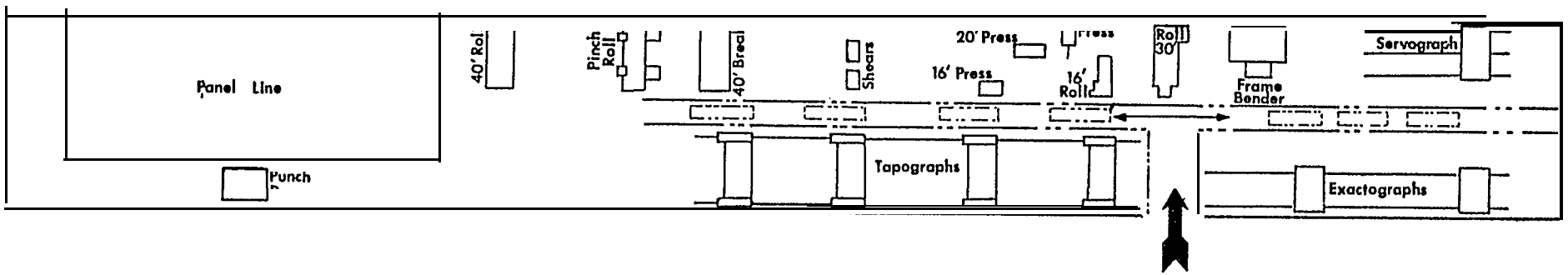

Panel Line
Punch
40' Rol
Pinch Roll
40' Breal
Shears
20' Press
16' Press
16' Roll
Roll 30'
Frame Bender
Servograph
Tapographs
Exactographs

Figure 9.

What is the optimum organizational pattern in a shipyard? We. must conclude from our own NC experience that a precise answer to this question does not exist. Many things influence a shipyard's operation: management attitudes, personnel availability, finances, and geographical limitations are but a few. Without consideration for any of these factors, a good NC structure for a shipyard should be as follows:

A computer applications section to develop or procure the software necessary for a good NC program;

A fairing group, established in a department, that has the ability to manually fair a ship, and the adaptability to learn computer fairing;

A scientific section that uses the data base for hull calculation programs, and provides the basic information needed for fairing and hulload;

A hull engineering department, producing accurate drawings by utilizing the data base for drafting purposes, and supplying detailed information for fairing and hulload;

A hulload group comprised of engineering and NC loft people -- initial loading of the data base should be done by hull engineering, with the NC loft, taking responsibility for the maintenance of hulload when part generation begins.

An NC mold mold, under production management, whose duties include part generation and nesting programming, as well as data base control -- this group should have access to whatever equipment is necessary to accomplish their duties.

A review of the NC operations of several successful shipyards will be an effective method of determining a suitable NC system. Such a study will enable management to decide what hardware, software, and organizational pattern would best suit their needs.